

National Aeronautics
and Space Administration

SEPTEMBER 17, 2002
NRA 02-OSS-04

NASA RESEARCH ANNOUNCEMENT

LIVING WITH A STAR SPACE ENVIRONMENT TESTBEDS

**NOTICE OF INTENT:
PROPOSALS DUE:**

**OCTOBER 17, 2002
DECEMBER 18, 2002**

LIVING WITH A STAR (LWS) SPACE ENVIRONMENT TESTBEDS (SET)

SUMMARY OF SOLICITATION

1. Summary of the LWS SET

NASA's Office of Space Science (OSS) issues this NASA Research Announcement (NRA) for the LWS SET to solicit investigations for its first project, SET-1. The goal of the LWS SET is to improve the capability to accommodate or mitigate the effects of solar variability on spacecraft design and operations. It will achieve its goal by performing investigations that include data collection from an experiment in space and from ground tests and then analyzing the data to improve the models, tools, and/or databases used for spacecraft design and operations. The improved products will reduce the requirements for margins to account for uncertainties in the definition of the induced environment (i.e., the environment in the presence of a spacecraft) and its effects on spacecraft design and operations. The savings in spacecraft resources that result from reducing the requirements for margins in spacecraft design and operations may permit the use of a larger science payload if the launch vehicle size is retained, a smaller launch vehicle if the science payload is unchanged (thereby reducing mission cost), and/or enable routine operations in new segments of the space environment (such as middle Earth orbit (MEO), altitudes between 2000 km and 10,000 km) at costs similar to those for operations at altitudes below MEO. Each investigation selected for this SET-1 Project and then down-selected at the end of a Study Phase will include the development of a space experiment, the collection of ground test data, and the reduction and analysis of space and ground data to develop investigation products. The SET-1 Project is expected to include several investigations and at least one flight opportunity. The space experiments in the SET-1 Project's investigations must be ready for integration with a host spacecraft in the 2005 timeframe and can include experiments that are directly attached to a host spacecraft through a unique, proposer-provided interface, as well as experiments that are attached to a host spacecraft through a SET-1 Project-provided standard interface called a Testbed Carrier. More than one destination or orbit in space may be available for the SET-1 Project experiments, depending on NASA's ability to identify secondary ride opportunities to carry them and/or the offer by proposers themselves to provide ride opportunities for SET-1 experiments.

Requirements for SET-1 investigations solicited through this NRA are divided into five categories as follows:

- (1) Characterization of the space environment in the presence of a spacecraft;
- (2) Definition of the mechanisms for materials' degradation and the performance characterization of materials designed for shielding from ionizing radiation;
- (3) Accommodation and/or mitigation of space environment effects for detectors and sensors;
- (4) Performance improvement methodology for microelectronics used in space; and,
- (5) Accommodation and/or mitigation of charging/discharging effects on spacecraft and spacecraft components.

These requirements are more completely discussed in Appendix A.

The SET-1 opportunity is open to U.S. industry, universities, Federally Funded Research and Development Centers (FFRDC), NASA Centers, other U.S. Government agencies, and non-U.S. organizations. Non-U.S. investigations are encouraged under a no-exchange-of-funds basis (see further information in the *NASA Guidebook for Proposers* discussed below). Regardless of its national origin, each proposed investigation is expected to contribute resources that will complement that provided by NASA. If the contribution serves only the single selected investigation or if NASA funds are requested, the proposer will be designated as an SET-1 Experiment Partner and a response to this NRA is appropriate. If the contribution will affect more than the proposer's investigation, a response to the Request for Information (RFI) entitled "Living with a Star Space Environment Testbed Partnerships" that was issued concurrently with the Federal Business Opportunities (FBO) Announcement for this NRA is appropriate instead of a response to this NRA.

Recommendations for selection of the proposals submitted to this NRA will be based on the peer evaluation of each proposal's intrinsic merit, its relevance to NASA's objectives, and its cost as specified in Section C.3 of the *NASA Guidebook for Proposers* (see further in the next paragraph). For the purposes of this NRA, intrinsic merit includes:

- the proposal's technical merits;
- the degree to which the investigation meets the requirements solicited;
- the overall feasibility of the end-to-end investigation including the approach and plan for achieving flight readiness for the experiment in the 2005 time frame;
- the degree to which the proposer has the requisite experience and organizational capability to deliver the experiment in a flight worthy configuration, to provide the supporting ground data (if applicable), and to complete the investigation; and,
- the commitment of the organization's management to the proposed technology development.

Relevance to NASA's objectives includes:

- the degree to which the proposed investigation meets the solicited requirements;
- the credibility of the basis for substantiating the projected margin, risk reduction, performance enhancements, or cost reductions; and,
- the need for space flight data.

Cost includes:

- the credibility of the entire budget for the investigation including the funding requested from NASA, value of all resources contributed by the proposer in lieu of funding, the funding contributed by the proposer (if applicable), and the products and services requested from NASA in addition to funding; and,
- the realism and reasonableness of the proposed cost, management structure, and schedule for the investigation approach to assure flight readiness in the 2005 time frame and a product at the end of the investigation.

Provided that proposals of sufficient merit are submitted, as many as 20 proposals may be selected for a six-month Study Phase, each funded through a contract (or other agreement) at no greater than \$50K each. At the conclusion of the Study Phase, each

selected investigator will be required to deliver a Study Phase Report that demonstrates that their proposed experiment is capable of being ready for integration into either a Testbed Carrier or directly onto a host spacecraft at the end of 2005 and that products can be delivered at the conclusion of two-years of data collection in space followed by a 6-month close-out period for the investigation. For planning purposes, proposers should assume that integration with the host spacecraft will require a period of one year after delivery of the SET-1 Project hardware for integration and that launch will occur immediately after integration has been completed. Detailed draft guidelines for the Study Phase Report are given in Appendix B of this document.

The Study Phase Reports will undergo a peer review process, and approximately half of the investigators submitting Study Phase Reports may be selected for further work (i.e., down-selected--to continue with the Concept Development and Implementation Phases of their investigations in the SET-1 Project). Each down-selected investigation may receive additional funding of no greater than \$200K for the completion of its investigation, and this completion includes the experiment build, integration, and test with either the host spacecraft or SET-1 Testbed Carrier; operations for a nominal period of two years; analysis of ground and space data; and production and delivery of final products within six months of the end of experiment operations in space. The total funding available for this SET-1 Project, including all phases of all investigations, the Testbed Carrier, and costs associated with integration to a host spacecraft, is about \$5M. Note that this NRA will be the only opportunity to propose to participate in the SET-1 Project as an Experiment Partner. In all cases, NASA's obligation to approve contract (or other agreement) awards is contingent upon the availability of funds for this LWS SET-1 Project.

2. Instructions for Preparation and Submission of Proposals

The policies and procedures for the preparation and submission of proposals, as well as those for NASA's review and selection of proposals for funding, are described in a separate document entitled *Guidebook for Proposers Responding to NASA Research Announcements* (abbreviated as *NASA Guidebook for Proposers*) that is accessible by opening the single Web site portal for the submission of proposals to any of the NASA program offices at the World Wide Web URL <http://research.hq.nasa.gov/>, and linking through the menu item "Helpful References," or may be directly accessed at URL <http://www.hq.nasa.gov/office/procurement/nraguidebook/>. By reference, this *NASA Guidebook for Proposers*, Edition: 2001 (May 2001) is hereby incorporated into this LWS SET NRA, and proposers to this NRA are responsible for understanding and complying with its procedures before preparing and submitting their proposals. Proposals that do not conform to its standards may be declared noncompliant and returned without review. Note that this *NASA Guidebook for Proposers* also provides supplemental information about the entire NRA process, including NASA's policies for the solicitation of proposals, guidelines for writing complete and effective proposals, and the policies and procedures for the review and selection of proposals, as well as for issuing and managing the subsequent funding awards. Also note that the NASA policy

for proposals involving non-U.S. participants is given in Section (I) of Appendix B of the *NASA Guidebook for Proposers* and in paragraph 2.1.

The World Wide Web site for submitting both a Notice of Intent (NOI) to propose to this NRA, which is encouraged but not required, and a Proposal Cover Page is given in Section 5, Summary Information, below (note that Chapters 2 and 3 of the *NASA Guidebook for Proposers* contain detailed information about these two items). After logging into the HQ data system at this Web site, a menu entitled "Division Specific Opportunities" will be presented. In order to gain access to the site for this LWS SET NRA, select "OSS Sun Earth Connection." Note that applicants to this NRA, whether PI's or Co-I's, must be registered with the database at this Web site.

2.1 Export Control Guidelines Applicable to Foreign Proposals and Proposals Including Foreign Participation

Foreign proposals and proposals including foreign participation must include a section discussing compliance with U.S. export laws and regulations, e.g., 22 CFR Parts 120-130 and 15 CFR Parts 730-774, as applicable to the circumstances surrounding the particular foreign participation. The discussion must describe in detail the proposed foreign participation and is to include, but not be limited to, whether or not the foreign participation may require the prospective proposer to obtain the prior approval of the Department of State or the Department of Commerce via a technical assistance agreement or an export license, or whether a license exemption/exception may apply. If prior approvals via licenses are necessary, discuss whether the license has been applied for or, if not, the projected timing of the application and any implications for the schedule. Information regarding U.S. export regulations is available at <http://www.pmdtc.org> and <http://www.bxa.doc.gov>. Proposers are advised that under U.S. law and regulations, spacecraft and their specifically designed, modified, or configured systems, components, and parts are generally considered "Defense Articles" on the United States Munitions List and subject to the provisions of the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120-130.

3. OSS Education and Public Outreach Program

The Office of Space Science is committed to fostering the broad involvement of the space science community in Education and Public Outreach (E/PO) with the goal of enhancing the Nation's formal education system and contributing to the broad public understanding of science, mathematics, and technology. Progress towards achieving this goal has become an important part of the broad justification for the public support of space science.

As a consequence of the plans and policies that have been established and implemented over the past several years, a significant national E/PO space science program is now underway as described by the OSS E/PO Newsletters and the Annual Reports that may be accessed by opening the "Education" link on the OSS homepage at <http://spacescience.nasa.gov>. This site also provides access to the two key documents

that establish the basic policies and guidance for all OSS E/PO activities: A strategic plan entitled *Partners in Education: A Strategy for Integrating Education and Public Outreach Into NASA's Space Science Programs* (March 1995), and an implementation plan entitled *Implementing the Office of Space Science Education/Public Outreach Strategy* (October 1996). Both of these documents may also be obtained in hard copy from Dr. Jeffrey D. Rosendhal, Office of Space Science, Code S, NASA Headquarters, Washington DC 20546; E-mail: jeffrey.rosendhal@hq.nasa.gov.

In response to the many constructive comments received from members of the space science community on how to improve, simplify, and streamline OSS's efforts to involve scientists in E/PO activities, substantial changes in procedures for incorporating E/PO into research awards were made starting in 2001 that are continued into 2002. These changes are intended to decrease the overall workload on the space science community, increase the likelihood that more E/PO proposals of merit will be funded, and more effectively encourage successful science proposers to add an E/PO component to their "parent" research effort. In addition, OSS has worked to open up new avenues for E/PO participation for space scientists and to develop a variety of approaches that allows such contributions to be recognized and acknowledged (details may be accessed through the "Education" Web site indicated above).

A summary of the key elements of the current OSS E/PO program that apply to this NRA are as follows:

- E/PO proposals are solicited only from those proposers whose research proposals have been selected for a research award under this NRA and then down-selected for the SET-1 Project Concept Development and Implementation Phase research awards;
- The cost cap on E/PO proposals by individual investigators is now \$15K per year;
- The total SET-1 Project budget that will be devoted to E/PO may be up to \$75K per year;
- Selected Principal Investigators have two windows of opportunity to submit an E/PO proposal, either: (i) no later than 45 days after the date of their letter of down-selection for participation in the SET-1 Project Concept Development and Implementation Phase research awards (with the anticipation of starting the E/PO activity within the six months of the down-selection; or (ii) no later than 75 days in advance of the yearly anniversary date of their letter of down-selection (with the anticipation of starting the E/PO activity in conjunction with the next year's funding increment for the award); and
- Consistent with past E/PO policies and to ease the burden of NASA's administration of such small supplemental awards, the total period of performance for any E/PO award is restricted to not exceed that of its parent research award.

For further details and specific guidance and information on preparing and submitting a proposal for E/PO funding under this or any previous OSS NRA, reference the Web site at <http://spacescience.nasa.gov/education/scientists/guidelines/index.html>. Questions and/or comments and suggestions about the OSS E/PO program are sincerely welcomed and may be directed to either Dr. Philip Sakimoto (telephone: 202-358-0949; E-mail: phil.sakimoto@hq.nasa.gov), Ms. Rosalyn Pertzborn (telephone: 202-358-1953; E-mail:

rpertzbo@hq.nasa.gov), or Dr. Larry Cooper (telephone 202-358-1531; E-mail lcooper1@hq.nasa.gov).

4. Items of Special Importance

(i) If additional programmatic information develops before the proposals are due, it will be added as Amendments to this NRA and posted at its Web site no later than 30 days before the proposal deadline. Although NASA OSS will also send an electronic notification of any such amendments to all subscribers of its electronic notification system (see item (iii) below), it is the responsibility of prospective proposers to check this NRA's Web site for updates concerning the Program Element(s) of interest.

(ii) OSS requires the electronic submission of certain key elements of proposals through the World Wide Web (see below in Section 5, Summary Information). While every effort is made to ensure the reliability and accessibility of this Web site and to maintain a Help Desk via E-mail, difficulty may arise at any point on the Internet, including the user's own equipment. Therefore, prospective proposers are urged to familiarize themselves with this site and to submit the required proposal materials well in advance of the proposal due date.

(iii) OSS maintains an electronic notification system to alert interested subscribers of the impending release of its research program announcements. Subscription to this service is accomplished through the listing "To subscribe to the OSS electronic notification system" found on the menu of the OSS research page at http://research.hq.nasa.gov/code_s/code_s.cfm. Owing to the increasingly multidisciplinary nature of OSS programs, this electronic service will notify subscribers of all NASA OSS program announcements regardless of the type and science objectives (about 10 to 15 per year). Regardless of whether or not this service is subscribed to, all OSS research announcements may be accessed from the menu listing, "Current (Open) Solicitations," at the Web site given above as soon as they are posted (typically by 8:30 a.m. Eastern Time on their date of release).

5. Summary Information Applicable to This NRA

Program Alpha-Numeric Identifier	NRA 02-OSS-04
Date of NRA Release	September 17, 2002
Access to text	Link through the menu listings “Research Solicitations” and then “Current (Open) Solicitations” starting from the OSS home page at http://spacescience.nasa.gov/ .
Guidance for preparation and submission of proposals (including default page limits)	<i>NASA Guidebook for Proposers Responding to a NASA Research Announcement (NRA)</i> at URL http://www.hq.nasa.gov/office/procurement/nraguidebook
Notice of Intent (NOI) to Propose (encouraged but not required): - Desired due date: - Web site for electronic submission:	October 17, 2002 Open appropriate menu listing at http://research.hq.nasa.gov/ (Help Desk E-mail: proposals@hq.nasa.gov)
Proposal Cover Page (including Budget Summary): - Deadline: - Web site for electronic submission:	Same as for proposals; print completed items from Web site http://research.hq.nasa.gov/ Same as above (Help Desk: E-mail: proposals@hq.nasa.gov)
Proposal page limits	15 pages

Submission of proposal (including printed Proposal Cover Page and Budget Summary):

- Required Number: Signed original proposal plus 15 copies.
- Deadline: 4:30 p.m. ET on December 18, 2002
- Address for submission by U.S. Postal Service, commercial delivery, or private courier:

LWS SET NRA
Office of Space Science
NASA Peer Review Services
500 E Street, SW, Suite 200
Washington, DC 20024
Telephone: 202-479-9030

Selecting Official	Director, Sun Earth Connection Division NASA Office of Space Science
Announcement of selections	Goal: 150 days after Proposal Deadline
Initiation of funding for new awards	Goal: 46 days after proposal selections or passage of NASA Fiscal Year 2003 budget, which ever occurs last
<p>Further information:</p> <ul style="list-style-type: none"> - Programmatic: <div style="margin-left: 40px;"> Dr. Dana A. Brewer Sun-Earth Connection Division Code SS Office of Space Science Washington, DC 20546-0001 Telephone: (202) 358-1678 E-mail: dbrewer@hq.nasa.gov </div> - For general NRA policies and procedures: <div style="margin-left: 40px;"> Dr. J. David Bohlin Sun-Earth Connection Division Code SS Office of Space Science NASA Headquarters Washington, DC 20546-0001 E-mail: david.bohlin@hq.nasa.gov </div> 	

Your interest and cooperation in responding to this NRA is appreciated.

Richard R. Fisher
Director
Sun-Earth Connection Division

APPENDIX A

LIVING WITH A STAR (LWS) SPACE ENVIRONMENT TESTBEDS (SET) - 1 PROJECT

A.1 Background

The Sun emits time-varying magnetic fields, plasmas, and energetic particles that interact with the Earth's magnetic field and outermost atmosphere to produce changes to the Earth's space environment. The LWS Program seeks to address the effects that this solar variability has on the Earth and its implications to humanity. In particular, the LWS SET Program addresses the effects of solar variability on the environment in the presence of spacecraft, i.e., the induced environment, by performing investigations that will improve the definition of the induced environment, validate performance prediction models, tools, and/or databases used for spacecraft design and operations, and develop or improve accommodation and/or mitigation techniques for the space environment effects.

The effects of these solar-induced changes on humanity increase every day due to humanity's increased reliance on new technology and increasingly sophisticated systems that have critical, space-based components. For example, the increased use of microelectronics technologies with better capabilities, smaller feature sizes, and higher packaging densities increases their vulnerability to ionizing radiation effects compared to technologies with larger feature sizes and lower packaging densities. Ground test protocols to quantify the radiation effects have been validated using space data for older microelectronics technologies but not for technologies with smaller feature sizes and higher packaging densities. This lack of validation increases the risk of using the technologies in space applications.

The LWS SET Program will consist of a series of projects, and each project will contain several investigations. Each investigation will contain an experiment that collects data in space and on the ground, the analysis of the data to provide products (i.e., improved models, tools, and/or databases) used for spacecraft design and operations, and the documentation and delivery of the improved products. For example, products may include a validated ground test protocol, a definition of a damage mechanism for space hardware, the development of an accommodation and/or mitigation technique for a space environment effect, or a better definition of the induced environment. Data collection in space is required, because the space environment cannot be simulated on the ground. A new SET project is expected to begin about every two years, approximately coinciding with the average time between new generations of electronic devices or components. Each SET Project is expected to provide one or more space flight opportunities.

Requirements for the investigations for the SET-1 Project fall into five categories as described in Section A.5.3 below. These requirements for investigations, their priorities, and examples of investigations that would satisfy the requirements were identified at the LWS SET pre-NRA Workshop on January 25-26, 2001. Information from this workshop is available at http://lws-set.gsfc.nasa.gov/Pre_NRA_Workshop_01250.htm

A.2 Concept of the Space Environment Testbed Carrier

The NASA-provided Testbed Carrier serves as the interface between the host spacecraft and the SET experiments and also provides a simple central processing unit (CPU) that is shared by the experiments that use the Carrier. It provides a fixed interface to the experiments that use it and a variable interface to the host spacecraft. Keeping the interface between the experiments and the Carrier constant provides maximum flexibility for manifesting SET experiments on more than one access-to-space opportunity. SET experiments are not required to use a Carrier, but for those that do, a set of interface guidelines is given in Section A.6 below.

SET experiments having two categories of dimensions may be proposed: “Box” experiments are those having enclosures where all three dimensions are similar, whereas “Board” experiments are those having one dimension that is significantly smaller than the remaining two dimensions. Board experiments will always interface to the Testbed Carrier unless the proposer is providing his own flight opportunity, whereas box experiments may interface either to the Testbed Carrier or directly to a host spacecraft.

A.3 Partnering

Because the SET Program has very limited resources available and because the selected investigators are generally expected to substantially benefit from the completion of their proposed investigations, all proposals for SET investigations must contain a significant resource contribution, thereby effectively become an “experiment partner” with NASA in the SET-1 Project. Examples of “experiment partner” contributions may include, but are not limited to:

Experiment hardware, ground test/analysis data, and reduction of data taken during space flight;

Near-real-time data reduction for experimenter-provided SET environment monitors so that the data can support other SET experiments that are flown on the same mission; and, Use of ground-based facilities for developing the SET experiment and/or personnel to develop the experiment and/or analyze the data.

Proposers may request funding from NASA to develop the experiment and/or analyze the data. Proposers may also request that NASA provide the following services: provision of correlative environment measurements taken during the flight of the experiment, arrangement for access to space for the experiment hardware, use of the Testbed Carrier if needed, and/or the timely return of data from space in a format suitable for analysis. NASA will not provide funding for the development of ground test protocols, technology, instruments, technology application models, environment specification models; host spacecraft; and mission operations for a host spacecraft.

A.4 Data Policy

The LWS SET Program is interested in performance characterization and induced environment data taken in space and on the ground that can be used to reduce the uncertainty margins for the design and/or operations of future spacecraft or missions. Acceptable investigations proposed to this NRA would provide performance data that are shared with U.S. and non-U.S. participants. The LWS SET will have provisions for archiving these data, and it is expected that the data will be available in this archive with

no more than a three-month delay after the data are delivered to the SET investigator. Therefore, proposers should include data reduction and transmittal for archiving as part of their investigation.

The end products of a SET investigation may include improvements to mathematical models, design tools, or databases of space environment effects. When these types of improvements are proposed as investigation products, such end products should include delivery of source codes and/or documentation that include the improvements, and these products will be shared and made publicly available consistent with U.S. law. End products that consist solely of publications in peer reviewed journals and/or presentations at conferences will not always be considered as sufficient products when investigations focus on improvements to models, design tools, and/or databases. Guidelines for delivery of software and databases are provided in Section A.8 below.

Two types of technology data, manufacturing and performance, are expected to be associated with the SET investigations. Manufacturing data are defined to include methods for producing devices, materials, or components that will be put under test in the space environment. These data are subject to the International Traffic in Arms Regulations (ITAR) and/or the Export Administration Regulations (EAR) and are not needed to satisfy the goals of the LWS SET Program. Therefore, manufacturing data are not requested and should not be included as part of the end products in a successful LWS SET proposal. Performance data should be included as part of the end products in a successful LWS SET proposal.

A.5 Specific SET-1 Investigation Requirements

The requirements for SET-1 investigations and examples of investigations that would satisfy a requirement are described below. They should not be interpreted as an exhaustive list of examples but instead should be viewed as examples that meet the broader objectives envisioned for the LWS SET Program. No investigation described below should be viewed as having a higher priority than any other investigation that meets these NRA requirements. Investigations that meet the objectives of this NRA and are not included in this section are encouraged and expected.

A.5.1 General Requirements

Experiments designed with maximum flexibility relative to their flight requirements will have more potential opportunities for access to space than experiments with less flexibility. Access-to-space opportunities have not been finalized for the SET-1 Project and may include more than one destination using either U.S. or non-U.S. launch opportunities. Proposers should specify acceptable space destinations to obtain the data needed for their investigations. To afford flexibility to take advantage of all access-to-space opportunities, proposers that do not provide a flight opportunity for their experiment as part of their contribution to the experiment partnership should plan to permanently attach devices or components to their board experiments and provide equivalent planning for box experiments. In all cases, *proposers should assume that no experiments will be returned from space unless the proposer has identified a separate partnered flight opportunity to do so.*

The LWS SET Program has developed interface guidelines for experiments that propose to use the Testbed Carrier; see Section A.6 below. Experiments that do not propose to use the Testbed Carrier to interface to the host spacecraft must include the resources needed to provide accommodation to a host spacecraft and the required correlative environment measurements in their investigation plans. Experiments that propose to use the Testbed Carrier and hence common interface guidelines for their experiment interfaces do not need to address the resources needed for accommodation to the host spacecraft or correlative environment measurements in their investigation plan, because they will be provided by the SET-1 Project.

Proposed investigations that focus on validating or characterizing hardware performance in space are acceptable for this NRA provided that the predictions of hardware performance prior to flight using analytical tools/models and/or environment test facilities on the ground are also included in the investigation. The LWS SET Program may fund analysis tasks in subsequent NRA's that would improve the performance prediction capability (and thus reduce needed margins) for spacecraft design and operations; these analysis tasks would require two types of performance data: predicted performance prior to space flight, and performance data from space. Accordingly, investigations submitted to this NRA should include the predicting of performance prior to flight using data from ground test facilities and/or analysis tools/models and the characterizing performance in space.

A.5.2 Correlative Environment Measurements

It is expected that each SET-1 investigation will need *in situ* environment measurements to correlate its experiment results with the state of the induced space environment at the time that the flight data are obtained. For example, measurements of the induced electron, atomic oxygen, solar ultraviolet, and/or proton environments may be needed. In order to maximize the use of resources, flight experiments that utilize the Testbed Carrier will be provided with correlative environment measurements as a resource. In addition, the SET-1 Project will provide each flight experiment with a dosimeter and a thermistor to be used directly on the experiment to capture its local environment. To maximize the ability to use small access-to-space opportunities, the SET-1 Project will customize the set of correlative environment measurements and the set of experiments to the flight opportunity. Investigators that propose to use the Testbed Carrier should specify their correlative environment measurement requirements as part of their proposed investigations.

The SET-1 Project expects to obtain correlative environment measurement data from three sources: shared data from induced environment investigations (see Section A.5.3.1 below); monitors and/or data provided as part of an LWS SET partnership; and, data provided by the SET-1 Project. Calibration data for the environment monitors will be included as part of the correlative environment measurement data that are delivered to space experiments that use the Testbed Carrier.

A.5.3 SET-1 Investigation Requirements

A.5.3.1 Induced Environment

The induced space environment is defined to include the environment outside as well as inside the structure of the spacecraft that exists because the spacecraft is in the space environment. In some cases, such as high-energy cosmic rays and solar particles, the induced environment in the spacecraft changes due to passage of the radiation through spacecraft structure, and the associated effects change due to the interactions during the passage. Effects also will change when the induced environment before and after passage through structure encounters humans and their blood-forming organs. Measurement of the effects on humans and hardware can only be achieved when (1) the sources of the differences between the induced environment and the environment in the absence of a spacecraft (i.e., the natural environment) are quantified, and (2) the correlation between the values of the induced environment and its effects is made. It is understood that data collected in space to support induced environment investigations will be made available to support (or correlate with) other SET investigations on the same flight opportunity in near-real time. In addition, NASA is only interested in induced environment investigations that take their measurements at or above low Earth orbit altitudes.

Examples of investigation needs for SET-1 induced environment investigations are:
Validation of induced environment monitors for those environments that change with solar variations;
Characterization of changes in the induced environment due to solar variability;
Characterization of changes in the induced environment due to the passage of high energy particles through and/or interaction with spacecraft hardware; and,
Intercomparison of environment monitors that measure similar energy ranges of the space environment.

A.5.3.2 Degradation and Shielding Properties of Materials

The development of reliable, longer-lived materials for space applications requires data collected from space because the combined environment in space cannot be exactly reproduced on the ground. In the past, materials experiments in space have been focused on materials and contamination, but investigations of materials applications have not generally been included. This NRA seeks investigations that include materials and materials applications whose performances change due to solar variability; investigations of neutral contamination that results from the unique characteristics of a spacecraft design are not sought. Proposers should assume that *experiments will not be returned from space* unless they include a flight opportunity that allows for experiment return as part of their contribution to the experiment partnership.

Examples of investigation needs for performance characterization and validation are:
Encapsulating shields for electronics devices;
Effects of the radiation environment on micro-electromechanical systems (MEMS);
Utilization of space-curable resins for inflatables and composites;
Material property changes from extended space environment exposure;

Variable emissivity coatings for thermal control;
Coating and shielding materials for optical fiber;
Conductive, charge-mitigating materials;
Exotic materials for spacecraft shielding;
Light-weight solar cell shielding;
Materials property monitors to measure the space environment effects on the material;
and,
Inorganic strain gauge materials.

A.5.3.3 Detector/Sensor Performance

Investigations that focus on accommodation and/or mitigation of space environment effects on detectors and sensors of all kinds with enhanced capabilities and with either the same or lower risk than proven technology are sought as SET-1 investigations. Although new generations of detectors and sensors with enhanced capabilities are being developed, their use in space will be inhibited until they have been subjected to space flight to validate measurements of parameters such as dark current, noise, quantum efficiency, coefficients of thermal expansion, dose rates, time dependent effects, and shielding that were made on the ground.

Examples of investigation requirements for performance characterization and validation that are appropriate for this NRA are:

Damage mechanisms for charge coupled detectors and hybrid Complementary Metal-Oxide Semiconductor (CMOS) detectors in the space environment;
Intercomparison of dosimetry sensors;
Validation of new detectors including active pixel sensors, gyroscopes, and focal plane arrays;
Approaches and techniques for radiation hardening of sensors and detectors;
Organic and inorganic sensors used for health monitoring; and,
Space environment measuring devices.

A.5.3.4 Performance Characterization for Microelectronics

The ability to use new Commercial Off-the-Shelf (COTS) technology in spacecraft and in several regions of the space environment can frequently improve the spacecraft capabilities compared to using hardened technology since, in general, hardened technology has less capability than COTS technology. For example, higher speed and bandwidth, enhanced onboard processing capabilities, reduced power and mass, and mitigation of space environment effects may be possible if the performance of the new COTS technology in space could be predicted. The performance prediction could be accomplished using validated prediction models, and/or ground tests if these methods were reliable. However, ground testing alone is not reliable due to the inability to accurately simulate the space environment in ground test facilities. Only limited studies of the differences between the space and ground-test environments have been made, and, due to limited statistics of the datasets, they are insufficient for use in validating the prediction models. Thus, improving the accuracy of the prediction of performance in

space requires data collection in space to characterize performance and to enable the validation of prediction models and ground test protocols.

The LWS SET Program proposes to reduce the uncertainty margins associated with performance predictions in two ways. First, it establishes the capability for data collection in space for performance characterization, and second, it requires that investigations that address performance characterization in space also predict the performance prior to flight using ground tests and models. That is, when appropriate, data on technology performance in ground tests should be collected prior to flight so that ground and space data can be used together to validate a ground test protocol. The space environment that will be experienced by the technology should be predicted prior to flight to assess the validity of the prediction tools. Correlative environment data should be requested so that it can be used later to validate the prediction models and the ground test protocols as well as to characterize the sources of the hardware performance/anomalies in flight.

Examples of categories of devices and materials for which performance characterization and validation of models are needed are:

Low-power photonic and MEMS devices;

Power generation, power distribution, power management, and thermal control devices for advanced electronics;

Advanced semiconductor materials categories such as CMOS, silicon-on-insulator, silicon-on-sapphire, silicon, gallium arsenide, silicon germanium, indium phosphide, indium arsenide, silicon carbide, wide band gap, magnetic, and chalcogenide-based semiconductors;

Microprocessors, memories, application specific integrated circuits, field programmable gate arrays, field effect transistors, digital signal processors, and hetero-bipolar junction transistors;

COTS technologies;

Linear bipolar devices; and,

Power converters and voltage references.

Studies of mechanisms, effects, and mitigation/accommodation methods of interest include:

Enhanced low dose rate sensitivity and related effects;

Single event effects such as upsets, latchups, transients, and burnouts;

Total ionizing dose and displacement damage dose;

Single event effects in combinatorial and sequential logic in deep sub-micron microcircuits;

Mitigation, hardening, and correction methods for ionizing radiation effects;

New environment tolerant or hardened devices; and,

System architectures such as reconfigurable computing, and on-board autonomy.

A.5.3.5 Charging and Discharging Effects on Spacecraft and Spacecraft Components

The increased use of high voltage solar arrays has increased the likelihood of arcing and propagation of arcs from structural materials and arrays, producing unexpected increases in performance degradation. The lack of information about the character and propagation of arcs, as well as contributions from other plasma effects such as sputtering, preclude development and validation of performance prediction tools and techniques for mitigating the plasma effects. The increased use of geosynchronous orbits increases the likelihood of two other plasma effects, electrostatic discharge and deep dielectric discharge, unless accommodation or mitigation techniques can be developed and used reliably. This reliability can only be achieved after these effects are characterized in space, and performance prediction models are developed and validated. Ground test protocols are not expected to be a substitute for space testing, since ground test facilities are not large enough to prevent current loops between the test articles and the facilities, and the neutral densities in the facilities are not low enough to simulate the space environment.

Examples of needs for investigations are:

Characterization of arcing from spacecraft structure including investigations of the solar array arc coupling in space;

Effects of plasma on solar array and spacecraft materials;

Validation of new solar array technologies;

Degradation of thermal performance of spacecraft structure and materials due to plasma effects;

Validation of spacecraft charge control devices; and,

Validation of monitors for deep dielectric charging, surface charging, and pulse discharging.

A.6 Guidelines for SET-1 Experiment Interfaces and Services

The following guidelines apply to all space experiments selected through this NRA.

Services and requirements unique to experiments that plan to use the Testbed Carrier are divided into two categories corresponding to board and box experiments.

A.6.1 General Integration Guidelines

A.6.1.1 Environment Requirements

Experiments should meet or exceed the contamination, electromagnetic interference, and shock and vibration requirements as defined in NASA Goddard Space Flight Center (GSFC) *General Environmental Verification Specification (GEVS) for STS and ELV Payloads, Subsystems, and Components*, Revision A for the ELV, available at the World Wide Web site: <http://arioch.gsfc.nasa.gov/302/gevs-se/toc.htm>.

A.6.1.2 Management Requirements

Proposed plans for the management processes for the investigation should meet or exceed the requirements of NPG 7120.5A, *NASA Program and Project Management Processes and Requirements*, available at the World Wide Web site:

A.6.2 Hardware and Services Provided to Users of the Testbed Carrier

A.6.2.1 Hardware

The SET-1 Project will provide the following to each box or board experiment that uses the Testbed Carrier:

Total ionizing dose (TID) dosimeter;
Temperature sensor;
Command and telemetry RS-422 interface chipset;
Card mount interface connectors; and
Connector savers.

Experiments that use multiple boxes or boards will be provided with one set of hardware for each box or board.

A.6.2.2 Assistance Provided by the SET-1 Project to Experiments

The SET-1 Project will provide scheduled use of a Verification Testbed and test support to experiments at the NASA Goddard Space Flight Center. Facilities are time-shared among all experiments and not available for development.

A.6.2.3 Use of Radioactive Devices on the Testbed

Radioactive sources are prohibited.

A.6.2.4 Services Provided by the Testbed Carrier

Services provided to all experiments that use the Testbed Carrier are defined below. Experiments that use multiple boxes or boards will be provided with one set of services for each box or board.

Parameter	Parameter Type	Parameter Value
Mechanical	Support	Provided
Power Availability	Voltages	Regulated +5V, -5V, +3.3V, +15V, -15V, or unregulated 28V
	Regulation	10 percent
	Keep-alive Service	Less than 100 mW after experiment is turned on
	Keep-alive Service	None at launch
	Types	Fused and switched
	In-rush current	Less than 1.5 times the steady state value for less than 50 msec
Commanding	Type	Conversion of ground-based Consultative Committee for Space Data Systems (CCSDS) commands to experiment-unique commands
	Format	RS-422 2-wire differential using a custom Universal Asynchronous Remote Terminal (UART)
	Baud Rate	76.8 kHz bit rate max, 38.4 kHz bit rate typical
	Burst Rate	1 kbps
	Command Processing	Delivery of stored, time-tagged commands to the experiment; code uploads to the experiment
	Real-time Capability	No real time commanding will be supported
	Autonomous Capability	Event-triggered commands accommodated (i.e., utilizes correlative environment measurements for triggering of commands)
Telemetry	Collection	Experiment-unique formats permitted within a standard serial packet
	Channel Allocation	4 analog channels per experiment allocated to (1) SET-provided temperature sensor. (2) SET-provided dosimeter, and (3 and 4) user defined
	Data Conversion	Experiment-unique data format converted by Testbed to CCSDS Source Format Data Units (SFDUs) for transmission to ground
	Aggregation	Provided
	Date and Time Stamping	Provided with accuracy of 1 second to Mission Elapsed Time (MET)

	Baud Rate	76.8 kHz bit rate max, 38.4 kHz bit rate typical
	Data Storage	1 kbps orbit average rate between downloads
	Burst Data Service	Negotiated service to be provided in either on-demand (by experiment) or polled service modes
Data Processing	On-board	Limited onboard data processing available on a negotiated basis
Thermal	Waste Heat	Mission-dependent removal

A.6.2.5 Board Experiment-Unique Services and Constraints

A.6.2.5.1 Unique Services Provided to Board Experiments

Experiments that use multiple boards will be provided with one set of services for each board.

A.6.2.5.2 Unique Constraints Placed on Board Experiments

Specifications are “per board,” and, if experiments with more than one board are proposed, the constraints are placed on each board in the experiment.

Constraint	Constraint Type	Constraint Value
Physical Parameters	Dimensions	10 x 13 x 4 cm not including connector space
	Mass	250 g
Power	Average	Less than 4 W
Commanding	Format	RS-422
Data and Command	Interface	RS-422 UART with single differential pair in each direction
	Real-time	Prohibited
Data Rate	Average	1 kbps
Thermal	Control	Board edges maintained to within the temperatures of –20 to +40 degrees C
	Waste heat removal	Less than 3 W power per board above the average power

A.6.2.6 Box Experiment-Unique Services and Constraints

A.6.2.6.1 Unique Services Provided to Box Experiments

Experiments that use multiple boxes will be provided with one set of services for each box.

A.6.2.6.2 Unique Constraints Placed on Box Experiments

Specifications are “per box,” and if experiments with more than one box are proposed, the constraints are placed on each box in the experiment.

Constraint	Constraint Type	Constraint Value
Physical Parameters	Dimensions	12 x 18 x 12 cm
	Mass	10 kg
Power	Radioisotope sources	Prohibited
	Average	Less than 10 W
Commanding	Format	RS-422
Data and Command	Interface	RS-422 UART with single differential pair in each direction
	Real-time	Prohibited
Data Rate	Average	1 kbps
Thermal	Control	Cold plate at 5 degrees C provided
	Waste Heat Removal	Less than 10 W above the average power

A.7 Schedule For Key SET-1 Events

The following summary schedule of key events must be used in proposals submitted in response to this NRA:

Milestone	Date (on or about)
Study Phase Mid-Term Report due	3 months after date of contract (ADOC)
Study Phase Report due	6 months ADOC
SET-1 Down-Selection Decision	8 months ADOC
Preliminary Design Review for Experiments	12 months ADOC
Confirmation Review and Approval to Enter Phase C/D (Implementation) for Experiments	15 months ADOC
Ship Experiments to be Integrated into Testbeds	20 months ADOC

Milestone	Date (on or about)
Launch Readiness	No earlier than 32 months ADOC, depending upon access-to-space opportunity
End of Space Flight	Guideline is 24 months after launch, depending upon access-to-space opportunity
End of Investigation including delivery of a Final Report and data	Guideline is 6 months after end of space flight

A.8 Guidelines For Data Products From SET-1 Investigations

Data products are defined to include all data taken in space and on the ground to support the investigation, reduced and/or analyzed data that may or may not be in a database, and models or tools developed or improved during the investigation. They are all expected products from the selected investigations and are expected to be archived and made available for use through the SET Web site; the SET Web site will have provisions for accommodating restrictions on distribution due to ITAR and EAR. No funding will be provided for development or maintenance of alternate Web sites.

If data that was produced from an investigation not funded by the LWS SET is needed to complete the proposed SET-1 investigation, a letter from the owner of the non-LWS SET data that verifies the availability of the data for the proposed SET-1 investigation should be included in the proposal, and costs associated with obtaining and analyzing the non-SET-1 data should be included in the SET-1 proposal.

A.8.1 Software Standards for Data Products

The following software standards should be used for all data products resulting from proposed efforts:

- ANSI standard programming languages;
- Compatibility with Netscape/Internet Explorer 4.0 or greater;
- No copyrighted software that cannot be distributed (i.e., graphics packages, etc.);
- A designated technical point of contact to assist SET personnel with installation of and testing of software on SET platforms, if necessary, for fine-tuning;
- Both source and executable software including any necessary scripts; and,
- Complete written documentation that includes a Users Manual ready for publication with compatibility with Microsoft Word 97 or later (online documentation and help is highly desirable).

A.8.2 Software Standards for Models and Tools

The following software standards should be used for all models and tools resulting from proposed efforts:

- A Web-ready, browser-client model designed to run on a Windows NT 98/NT platform using an Internet Information Server (IIS), and
- A second, stand-alone model that will run on a Windows NT 98/NT platform.

A.8.3 Software Standards for Databases

The following additional software standards should be used for all databases resulting from proposed efforts:

- Compatibility with Microsoft Access 97 or later,
- Stand-alone capability, and
- Inclusion of queries (searches), forms, and programmatic elements.

APPENDIX B

DRAFT GUIDELINES FOR THE CONTENT OF THE STUDY PHASE REPORT FOR THE FIRST SPACE ENVIRONMENT TESTBED (SET) FLIGHT PROJECT, SET-1

B.1 Introduction

This appendix provides the draft guidelines for the preparation of the Study Phase Report that investigators selected through this NRA will be required to submit. The SET-1 Project will finalize these instructions prior to the initiation of the Study Phase activities. The draft guidelines are provided in this NASA Research Announcement (NRA) to permit more accurate cost proposals to be submitted to this NRA.

B.2 Submission of Information

B.2.1 Certification

The original copy of the Study Report shall include a Letter of Commitment signed by an official of the providing organization. This official shall certify institutional support and sponsorship for the experiment, its investigation approach, and its management and financial proposal.

B.2.2 Report Submittal

Ten copies of the Study Report shall be submitted in accordance with the schedule given in paragraph A.7 to the following address:

TBD

B.3 Content and Format

The Study Report shall contain investigation information divided into the following sections:

Executive Summary;
Investigation Approach;
Management Approach;
Experiment/Technical Approach;
Product Delivery Approach;
A Cost Plan; and,
Appendixes.

The content of each of these sections is discussed in the following sub-sections of this Appendix.

The Study Report shall conform to the following page limits, including no more than two foldout pages (28 x 43 cm; i.e., 11 x 17 inches). The Cover Page, Table of Contents, Cost Plan, and Appendixes will not be counted against the page limit.

SECTION	PAGE LIMIT
Cover Page and Table of Contents	No page limit
Executive Summary (including Fact Sheet)	3
Investigation Approach, Management Approach, Experiment/Technical Approach, and Product Delivery Approach	25
Cost Plan	No page limit, but data shall be presented in formats described and submitted as a separate document; be brief
Appendixes (No other appendixes permitted): Resumes Letters of endorsement Statements of work for phases beyond the down-selection Relevant experience and past performance Reference list Acronyms (optional)	No page limit

B.3.1 Executive Summary

The Executive Summary shall provide an overview of the investigation, including a description of how ground data, flight data, and analyses will be combined to yield a product that is applicable to the LWS SET goals. It should include a description of how the experiment approach, including the partnering, contributes to the success of the investigation. This Summary should be no more than three pages in length, including a one-page Fact Sheet. The Fact Sheet should include a drawing or picture of the experiment, contain no proprietary information, be suitable for public release, and use the format shown in Figure B.3.1-1.

Figure B.3.1-1. Fact Sheet Format.

Category of Space Environment Testbeds Investigation:	POC Name/Org: POC E-mail:
Investigation Title:	URL's for additional information

Picture /Drawing

Description of Investigation:
Description of How Ground data, Flight Data, and Analysis Contribute to the Investigation:
Investigation Product:
Benefits to Users/Customers:

Tasks and Plans for Data Collection in Space and Product Delivery	
Task Description	Completion/Delivery Date

B.3.2 Investigation Approach

This section shall describe the investigation including approaches for the following: ground data/performance prediction prior to flight; obtaining flight data using the experiment; data analysis; product delivery; and, partnering contributions to the investigation.

An investigation plan is required to support the project's approval to begin the Implementation Phase, and it shall include the following:

- A description of the investigation including the nature of the subject of the investigation, future applications, uncertainties in the definition of the induced environment and/or its effects to be addressed, target customer(s), etc.;
- Objectives of the investigation;
- A plan for integrating the data collection from the space experiment with other data and with analysis to reach a product that will reduce the design and/or operations margins for future spacecraft;
- An overall plan that includes experiment hardware development to reach the readiness for flight, ground and flight test plans, data collection required to define a range of applicability for the investigation, and product types, content, and delivery schedule;
- Schedules and milestones for the investigation;
- A description of data records for each type of data being collected;
- Data analysis plans; and,
- Product delivery including a description of how ground, preflight, and flight and analysis segments contribute to the overall investigation.

B.3.3 Management Approach

The Study Report shall reflect the integration of the investigation into the SET-1 Project that will define each investigation as a discrete technical task. Investigators should plan to support SET-1 Project management by providing the information needed to perform representative project management functions such as:

- Developing requirements and goals for project success;
- Preparing the experiment plans;
- Conducting mission and operations planning;
- Providing oversight management for the development, design, build, assembly, test, launch, and operations of the engineering system to meet to the requirements and goals for project success;
- Managing resources;
- Reporting performance and status to LWS SET management;
- Performing safety and missions assurance;
- Assessing and managing risk;
- Reporting investigation results;
- Certifying flight readiness;
- Delivering experiment data;

- Delivering investigation products;
- Archiving project data; and,
- Project closeout.

A description of the approach for managing the experiment, the recognition of essential management functions, and the overall integration of these functions with the SET-1 Project should be included. Information that gives insight into the organizations proposed for the task, including the internal operations and lines of authority with delegations, internal interfaces and relationships with NASA, major subcontractors, and partners should be provided. The institutional commitment and the organizational roles and responsibilities should be identified.

B.3.3.1 Management Processes and Plans, Schedules and Procurement Strategy

Describe the management processes and plans, schedules, and procurement strategy necessary for the logical and timely performance of the investigation, accompanied by a description of the Task Plan. Also describe the proposed methods of hardware and software acquisition. Specifically, include the applicable capabilities that each partner or proposed partnering organization expects to contribute, as well as previous experience with similar investigations.

Identify the specific decision-making process regarding all aspects of the investigation, including any potential descoping and distribution of reserves, and the individual with ultimate decision-making authority.

The schedule and workflow should be clearly laid-out, including critical path and schedule margins, deliveries of end items, and major interdependencies.

Discuss the method for internal review, control, and direction.

B.3.3.2 Responsibilities

This section should describe the roles, responsibilities, time commitment, and experience of key personnel, with particular emphasis placed on the responsibilities assigned to the experiment Principal Investigator and other key personnel.

B.3.3.3 Organizational Structure

Provide the organizational structure of the investigation. Describe the responsibilities of each organizational element and its contributions to the experiment. Each key position, including its roles and responsibilities, how each key position fits into the organization, and the basic qualifications required for each position, should be described. A discussion of the unique or proprietary capabilities that each member organization brings to the experiment should be included. The contractual and financial relationships between partners should be discussed.

Summarize the relevant institutional experience in this section, and refer to supporting detail included under this NRA

B.3.3.4 Risk Management

This section should describe the approach for risk management in the flight experiment including the plans for using deterministic methods such as Failure Modes and Effects Analysis (FMEA), Fault Tree Analysis (FTA), and Probabilistic Risk Assessment (PRA)

and software Independent Verification and Validation (IV&V). Particular emphasis should be placed on describing how the various elements of risk, including margins allocation, will be managed to ensure successful accomplishment of the flight experiment within cost and schedule constraints.

B.3.3.5 Government-Furnished Property, Services, Facilities

This section should delineate the Government-furnished property, services, facilities, etc. required to accomplish all phases of the investigation. Include approval letters from the cognizant Government contracting officer for the use of the property, service or facilities.

B.3.3.6 Reporting and Reviews

This section should describe the approach for reporting progress to the SET-1 Project, and the reviews the project is invited to attend to provide independent oversight. The process, including the individual or organization responsible for reporting integrated cost, schedule, and technical performance should be discussed.

Investigators should plan to provide information or support, as a minimum, to the following reviews during the phases after down-selection: Preliminary Design Review, Critical Design Review, Flight Readiness Review, and other appropriate reviews associated with the carrier and launch vehicle integration. Each investigator shall be required to support the project in a monthly telecon on the technical progress and in quarterly management reviews including technical progress, cost and schedule status, etc.

B.3.4 Experiment/Technical Approach

This section shall fully describe the design merit of the experiment in support of the investigation including engineering and requirements flow-down, resource requirements/allocation, risk assessment, design margins that are cost drivers, test and analysis, and software verification and validation. It shall show that the achieved experiment performance will meet the LWS SET goals.

B.3.4.1 Experiment Design

This section shall describe the flight experiment's data collection. It should include:

- A discussion of the role that the experiment performs in the investigation and how the data will be collected and analyzed;
- The reaffirmation of the rationale for space flight and justification for the selection of the operations approach;
- Description of the flight experiment operations scenario, including orbital parameters, a preliminary mission timeline indicating periods of data acquisition, data downlink, etc.;
- Block diagrams, layouts, calibration plans, operational and control considerations, and software development;
- An identification of the proposed access-to-space platform including a justification for why the Testbed Carrier was or was not selected for use;
- The resource information pertinent to the accommodation of the experiment in the Testbed Carrier;
- Identification of any major open acquisition plans, partnering, or problems and methods to resolve them planned during the phases after down-selection; and,

- A description of the flow of experiment data for the completion of the investigation and product delivery.

B.3.4.2 Experiment Development, Integration, and Test

Describe the experiment development approach to produce and verify the hardware and software deliverables for space flight. Include a description of the main processes/procedures planned for the flight hardware and software development, supported by the detailed schedule for planned activities.

Discuss the testing strategy of the experiment prior to integration with the Testbed Carrier or host spacecraft as appropriate.

B.3.4.3 Approach for Access-to-Space

Describe the access-to-space approach. Fully identify the experiment characteristics and requirements including a description of any special hardware and software requirements (beyond those described in the paragraph A.6). This description should include: experiment mission design, mass, volume, power, pointing knowledge and accuracy; and logistics support.

B.3.4.4 Experiment Flight Operations

Describe the planned approach for the flight experiment operations. Describe the operational phase scenario. Identify all operational constraints. Describe any special communications, computer security, tracking, or near real-time ground support requirements, and indicate any special equipment or skills required of ground personnel.

Describe the acquisition of data and the processing of that data both in space and on the ground. Discuss the plan for processing the experiment data after it has been delivered to the ground, including the method and format of the data reduction, data validation, and preliminary analysis. Discuss requirements for correlative environment data. Discuss the process by which data will be prepared for archiving and analysis for incorporation into the overall investigation products.

B.3.4.5 Product Assurance and Safety

Describe the process by which the product quality is assured, including identification of trade studies and the parts selection strategy. Also describe the product assurance plan, including plans for problem/failure reporting, inspections, quality control, parts selection and control, reliability, safety assurance, and software validation.

B.3.5 Product Delivery Approach

Effective planning is required to enhance the probability that products from each investigation will be available for use in the design and operations of future space missions. Thus, it is important not only to describe the plan for analysis of flight data, but also to show how the plan is linked to product delivery. Therefore, this section should describe the plan for product delivery including:

- Required participation by the investigation provider, user, and SET-1 Project office;
- Methods to provide products for use by future spacecraft developers and operators, and the transfer of the products to customers; and,
- A schedule for product preparation, documentation, and delivery.

B.3.6 Cost Plan

The cost plan shall provide information on the anticipated costs for all aspects of the investigation. Sufficient cost detail shall be submitted to enable the SET-1 Project to make a fair and reasonable assessment of the total cost of the proposed investigation. Cost differs from “funding,” which is defined in the Funding Profile section below. The total cost is the total amount of resources used for all investigation activities including any NASA funding from projects, programs, or organizations other than the SET-1 Project and all non-NASA funded contributions. Include direct and indirect costs that contribute to the experiment regardless of funding sources. The total cost includes the full cost of all Civil Service support to the experiment, including the experiment hardware and software provided, task management staff, technical advisors, facilities, etc.

Direct costs include: (a) salaries and other benefits for employees who work directly on the investigation, (b) materials and supplies used directly in support of the investigation; (c) various costs associated with office space, equipment, facilities, and utilities that are used exclusively to produce the experiment; and (d) costs of goods or services received from other segments or entities that are used to produce the experiment.

Indirect costs include resources that are jointly or commonly used to produce two or more types of products but are not specifically identified with any of the products. Typical examples include labor overheads, material handling, cost of money, general administration, general research, and technical support, security, rent, employee health and recreation facilities, operating and maintenance costs for buildings, equipment, and utilities.

Cost estimating procedures shall be based upon generally accepted cost accounting principles and practices and shall be in accordance with the investigator’s approved accounting system.

The methods by which the cost estimates are derived shall be described.

Costing of Federal Government elements of proposals shall follow the agency cost accounting standards for full cost. If no standards are in effect for the agency, then follow the Managerial Cost Accounting Standards for the Federal Government as recommended by the Federal Accounting Standards Advisory Board. NASA Centers may submit full cost proposals based on the instructions in the NASA Financial Management Manual, Section 9091-5, Cost Principles for Reimbursable Agreements.

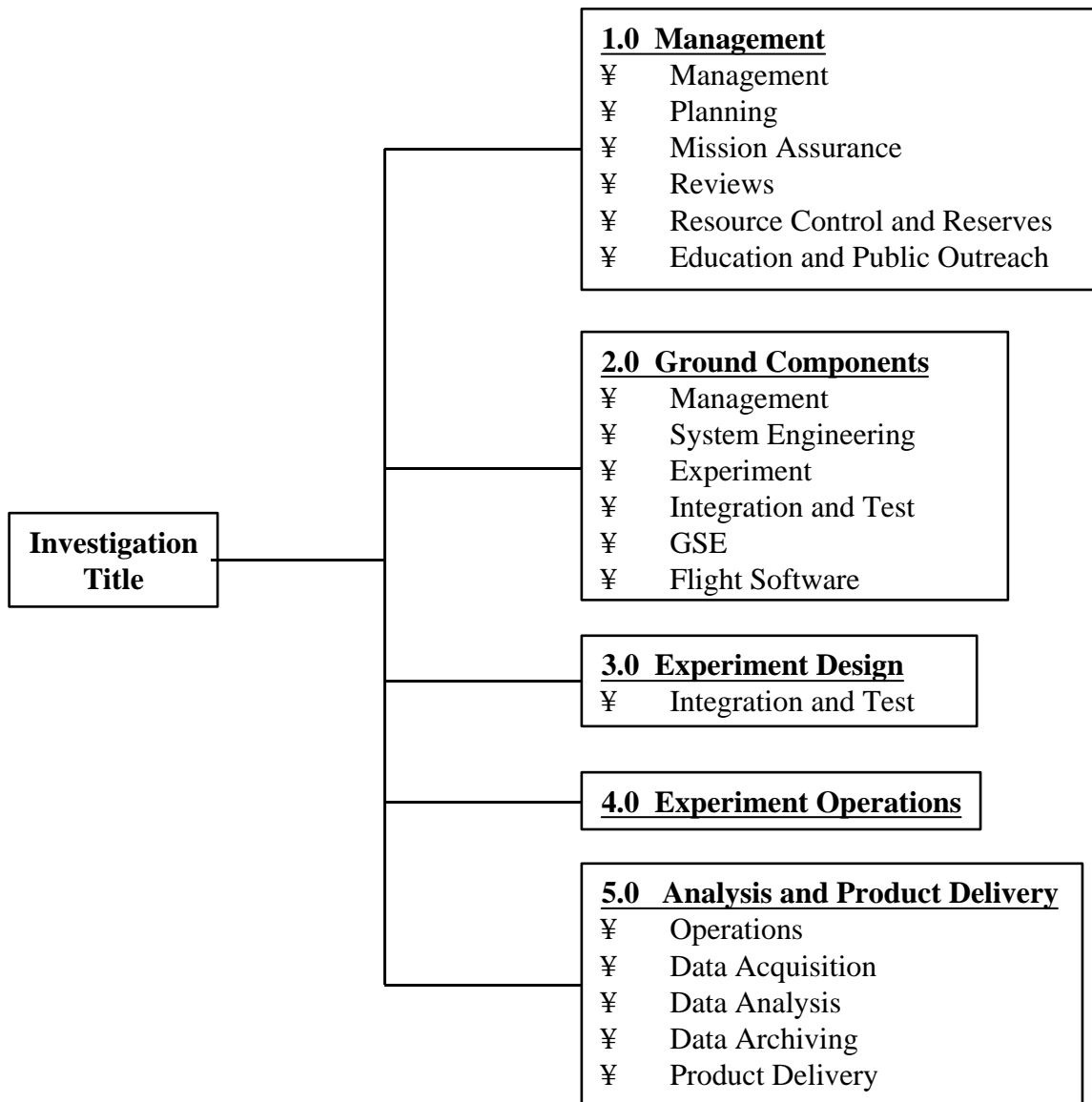
All costs shall be in U.S. real year dollars. Real year dollars are current fiscal year (FY) dollars adjusted to account for inflation in future years. The inflation rate index provided in Figure E.5-1 shall be used to calculate all real year dollar amounts unless an industry forward pricing rate is used. Where cost phasing is requested, the cost plan shall provide data by U.S. Government Fiscal Year (October 1 – September 30).

Table B.3.6-1. NASA New Start Inflation Rate Index.

Fiscal Year	2001	2002	2003	2004	2005
Inflation Rate (Percent)	3.1	3.1	3.1	3.1	3.1
Cumulative Inflation Index	1.031	1.063	1.096	1.130	1.165

Costs shall be broken down in accordance with the proposer's Work Breakdown Structure (WBS), which shall be included. A sample WBS to the sufficient level of detail has been included as Figure B.3.6-1.

Figure B.3.6-1 Sample Work Breakdown Structure (WBS).



A summary of total experiment costs by fiscal year as shown in Figure B.3.6-2 shall be completed in Real Year dollars.

Figure B.3.6-2. Total Cost Funding Profile.

Cost Element**	Costs in Real Year Dollars				
	FY1	FY2	FY3	FYn	Total
Phase B	\$	\$	\$	\$	\$
- Organization A					
- Organization B					
- etc.					
Phase C/D including 30 days after launch for checkout	\$	\$	\$	\$	\$
- Organization A					
Operations (30 days after launch to end of mission)	\$	\$	\$	\$	\$
- Organization A					
Experiment Interface and services	\$	\$	\$	\$	\$
- Organization A					
Telemetry and Data Downlinking	\$	\$	\$	\$	\$
- Organization A					
Other (specify)	\$	\$	\$	\$	\$
Total Cost to NASA	\$	\$	\$	\$	\$
Additional Contributions by other Organization to:					
Total Phases A and B	\$	\$	\$	\$	\$
- Organization A					
Total Phase C/D including 30 days after launch for checkout	\$	\$	\$	\$	\$
- Organization A					
Total Operations (30 days after launch to end of mission)	\$	\$	\$	\$	\$
- Organization A					
Integration, Data Collection not Costed in Other Categories, Data Analysis, Product Delivery	\$	\$	\$	\$	\$
- Organization A					
Other (specify)	\$	\$	\$	\$	\$
Contributed Costs (Total)	\$	\$	\$	\$	\$

Note: Costs should include all costs including fee

Identify reserves by phase but do not include the cost of the Study Phase.

Include costs for reviews. Assume any project reviews will be conducted at the NASA Goddard Space Flight Center in Greenbelt, MD.

Figure B.3.6-3 Cost breakdown by Work Breakdown Structure (WBS).

WBS/Cost Category Description	Cost in Real Year Dollars			
	FY2002	FY2003	FY 200n...	Total
WBS 1.0 Management	\$	\$	\$	\$
WBS 2.0 Flight Hardware	\$	\$	\$	\$
WBS 3.0 Access-to-space	\$	\$	\$	\$
Etc.	\$	\$	\$	\$
Total Experiment Cost	\$	\$	\$	\$
Total Other Costs to NASA	\$	\$	\$	\$
Operations Costs	\$	\$	\$	\$
DSN and Tracking Support				
Other (Specify)	\$	\$	\$	\$
Total Cost to NASA	\$	\$	\$	\$
	\$	\$	\$	\$
Total Contributions by Other Organizations				
Organization A:	\$	\$	\$	\$
WBS # and Description				
Etc.				
Organization B:				
WBS # and Description				
Etc.				
Total Cost By Fiscal Year				

Include a summary of costs by WBS to Level 3, by Fiscal Year as shown in Figure B.3.6-3, and giving the following direct and indirect elements:

Direct Labor Costs: The labor costs shall be identified for each Fiscal Year.

Labor Overhead: Overhead shall be itemized by Fiscal Year.

Subcontracts: Supporting information shall be provided for all subcontracts exceeding \$500,000. This detail shall include name/address, cost, fee/profit, and type of contract, basis of selection, and concise basis of estimate, and basis of selection.

Materials: Supporting detail for major vendors (exceeding \$500,000) shall include WBS element, Fiscal Year, description, vendor name/address, quantity, and current/proposed unit prices. Material burden rates shall be documented.

Other Direct Costs: Other direct costs (including travel) shall be summarized as totals for each Fiscal Year.

General and Administrative (G&A) Expense: G&A expense represents the institution's general and executive offices and other miscellaneous expenses related to business.

Cost of Money (COM): COM represents interest on borrowed funds invested in facilities.

Profit/Fee: Document the basis, rate, and amount of profit.

Escalation Factors: If different than Figure B.3.6-1, document the escalation factors used to determine real year dollars.

In addition to the summary of cost information, the proposer shall provide the following information:

Summary of Cost Reserves and Margins: A summary of cost reserves and margins should be identified by fiscal year and project element and the rationale for them discussed. The specific means by which integrated costs, schedule, and technical performance will be tracked and managed should be defined. Management of the reserves and margins, including the management organization person responsible for managing the reserves, and when and how the reserves are to be released, should be discussed. This should include the strategy for maintaining reserves as a function of cost-to-completion. All funded schedule margins should be identified.

Cost Management: The specific means by which costs will be tracked, managed and reported to the SET-1 Project shall be defined. A WBS shall be included. All funded schedule margins shall be identified.

Funding Profile: Provide a profile of required SET-1 Project funding by Fiscal Year. The funding profile is derived from the cost profile, which is the basis of the proposal. The funding for a given Fiscal Year is determined from the estimated costs in that year, less funding carried over from the previous Fiscal Year, plus the forward funding needed to cover the costs of the first month in the following Fiscal Year, plus the forward funding required for "unfilled orders." Unfilled orders refer to long-lead items for which funding and costing takes place in different Government Fiscal Years. Because of forward funding, costs will not equal funding in any given Fiscal Year. Total costs shall equal total funding at program completion.

B.3.7 Appendixes

Resumes of investigators, letters of endorsement, statement(s) of work, and past performance are additional information required to be supplied with the Study Report. This information can be included as Appendixes to the Study Report and will not be counted in the specified page limit.

B.3.7.1 Resumes

Provide resumes for all key personnel identified in the Management Approach section. Include resume data on experience related to the job these personnel will be doing for the proposed investigation. Limit to one page each (five pages total).

B.3.7.2 Letters of Endorsement

Letters of endorsement shall be provided from all organizations participating in and critical to the investigation. Letters of endorsement should be signed by both the lead representative from each organization represented and by institutional and/or Government officials authorized to commit their organizations to participation in the proposed investigation.

B.3.7.3 Statement(s) of Work

Provide draft Statement(s) of Work for all potential contracts (or other agreements) with NASA. These Statement(s) of Work should (as a minimum) be for each contract phase (Phase B, Phase C/D, Operations, Data Analysis, and Product Delivery) and for interim and final reporting. Clearly define all proposed deliverables for each phase, potential requirements for Government facilities and/or Government services, and a proposed schedule for the entire investigation.